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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003905934 for a patent by ANUTECH PTY LIMITED as filed on 28 October 2003.

WITNESS my hand this
Ninth day of November 2004

A handwritten signature in cursive script, reading "J. Billingsley".

JULIE BILLINGSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES



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AUSTRALIA
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PROVISIONAL SPECIFICATION

for the invention entitled:

"Rotation of a body about an axis and moveable clamp for use in that rotation"

The invention is described in the following statement:

Technical field.

This invention concerns the rotation of a body about an axis. More particularly, it concerns the controlled rotation of a large body about an axis.

This invention was developed to provide effective actuation and control of structures on which are mounted large dish antennae (such as the dish antennae used in radio telescopes, solar energy collectors and satellite communication systems) and for this reason the large dish antenna application of the invention will be featured in this specification. However, it should be appreciated that the present invention is not limited in its application to the rotation of such structures.

It should also be appreciated that the present invention is not constrained with regard to the radius of rotation of the body, which may be infinite (that is, with suitable guide arrangements, the invention can provide linear motion of the body). With finite radii of rotation, the allowable rotation of the body - clockwise or anticlockwise - can extend to more than 360°, if necessary.

Background to the invention.

Antennae for receiving signals from satellites or radio stars, and for receiving solar energy, often employ a large reflecting dish to focus electromagnetic radiation onto a receiver placed at the focus of the dish. The dish, comprising a reflective or conductive surface mounted on a rigid support frame or structure, is physically moved so that the pointing axis (or sighting axis) of the dish tracks, or points squarely at, the source of the electromagnetic radiation. This movement is normally about two axes, usually being rotation about a vertical axis and a horizontal axis (the so-called "azimuth/altitude tracking"). Less frequently, the dishes may be actuated on polar and equatorial axes (to effect "polar/equatorial tracking") of the radiation source. In the case of a large solar energy collector, various design considerations

have led to the use of azimuth/altitude tracking being favoured.

The conventional technique for effecting rotation of a large antenna structure about a vertical axis involves the use of a motor which drives a pinion that engages with a toothed track. Usually, the track is constructed in an arcuate or circular form with the required axis of rotation also being the centre of curvature of the arc or circle. The motor, which may be either electrically or hydraulically powered, drives the pinion through a reduction gearbox so that the antenna is rotated slowly, but continuously, about the required axis.

The electric or hydraulic motor required to rotate large bodies, and the reduction gearbox, are expensive components. Also, the operational strategy that is used, in the case of large solar energy collectors, is to actuate the antenna structure in a manner that is not truly continuous, but is intermittent. Thus the dish is usually rotated intermittently in steps, with periods of rest (no rotational movement) in between. This strategy avoids the need for extra power that would otherwise be required to suppress the "hunting" phenomenon that can occur when buffeting winds act on dishes that are being truly continuously rotated. (This "hunting" can be reduced by suitable design of the dish, as shown in the specifications of Australian patent No. 700,607 and U.S. patent No. 5,934,271, but it cannot be eliminated.) Thus large solar energy collectors are now usually operated in a manner that allows correction of the orientation of the pointing axis of the reflector every few seconds (the actual period between actuations depends on the time of day, and the consequent different apparent motion of the sun in relation to each tracking axis). This approach is potentially more economical in terms of the total amount of energy used to track the sun but, in the case of movement of the antenna by a motor and pinion drive, transients of high energy demand occur during the continual starting and stopping of the motor. This presents the need for ramping drives (with appropriate switchgear) while starting and while stopping, to

ameliorate the magnitude of the transients. This, in turn, makes the drive system even more expensive and potentially more prone to maintenance demands.

Another operational feature of large solar energy collectors is that, in the event that there is a failure of the tracking drive power, the antenna must be "off-steered" rapidly to avoid damage to the solar energy receiver. An "off-steering" device requires a back-up power supply, typically a bank of batteries which require regular maintenance, and this adds to the cost of the tracking equipment.

A recent alternative mechanism for rotating large solar energy collectors and other large bodies is described in the specification of European patent application No. 01121066.3.

That mechanism, which is also described in the specifications of Australian patent No. 677,335 and U.S. patent No. 5,757,335, involves an arm attached to or forming part of the body to be rotated, a hydraulic ram having its ram cylinder connected to the arm, and a plurality of substantially equi-spaced anchor members which lie on a circle or an arc of a circle. The plane of this circle or arc is orthogonal to the axis of rotation of the body. The end of the ram rod of the hydraulic ram which is remote from the ram cylinder is guided from one anchor member to an adjacent anchor member, where it is locked in place while the ram is activated. Activation of the ram moves the ram cylinder relative to the anchor members, and thus moves the arm and causes the body to rotate about the axis.

This alternative rotation mechanism is substantially less costly than the conventional drive motor and its associated accurately laid track with which the pinion driven by the motor engages, and its "off-steering" mechanism, for emergency use in the event of a power failure, can be the same hydraulic ram arrangement, driven by pressurised gas from a cylinder of the gas. It will rotate a large solar collector antenna at least as effectively as the conventional motor and pinion drive mechanism. However, it does have some disadvantages.

These disadvantages include the fact that the anchor members, which have to be

substantially equi-spaced on a platform, must be mounted with care, to ensure that the end of the ram rod is successfully transferred to an adjacent anchor member every time such movement is required. This problem is accentuated if fewer anchor members are used, with the consequential need for rams of longer stroke. Even with careful mounting of the anchor members, a number of operational conditions and factors can combine to cause the engagement of the end of the ram rod with the new anchor member to fail, even when care is taken to calibrate the whole system to more accurately locate the positions of the anchor members in the memory of the control computer, to ease the problem of the rod end failing to locate and lock onto the next anchor member. Techniques that may be employed to avoid this situation result in an increased cost and complexity of the system. The increased complexity means that maintenance problems are likely to be encountered.

Also, in spite of rapid computer control processes, the time taken for the end of the rod to move from a particular anchor member to the adjacent anchor member is significant and can cause a momentary undesirable tracking delay, allowing the receiver to lag slightly behind the sun. This problem can be ameliorated by deliberately causing the dish structure to move slightly ahead of its required position just before the changeover manoeuvre commences, and the use of extra tracking energy.

Disclosure of the present invention.

It is an object of the present invention to provide a new mechanism for rotating a large body about an axis, which is suitable for use with large dish antennae, and which (a) is both less costly and more reliable than either the conventional motor and pinion arrangement or the mechanism described above in which the end of a rod is moved from one anchor member to an adjacent anchor member, and (b) is also suitable for the rotation of other large bodies.

This objective is achieved by positioning the body within or above a ring member or an arcuate member, with the centre of curvature of the ring or arcuate member being the axis of rotation of the body, and connecting the body, via a rigid arm if necessary, to one end of a linear expansion and contraction device (for example, a hydraulic ram arrangement or

an electrically powered turnbuckle). The other end of the linear expansion and contraction device is connected to a clamp (an actuation clamp) which is positioned to clamp firmly to the ring or arcuate member, but which, when not so clamped, can be moved along the ring or arcuate member. The body is rotated about its axis of rotation by clamping the clamp onto the ring or arcuate member, then activating the linear expansion and contraction device. The end of the linear expansion and contraction device which is remote from the clamp is thus moved, and so is the body, or the arm attached rigidly to the body. That movement translates into rotation of the body about its axis of rotation. Thus it is preferred that the linear expansion and contraction device is mounted so that it is substantially tangential to the ring or arcuate member.

Release of the clamp, followed by activation of the linear expansion and contraction device in the opposite direction, leaves the body at rest in its new position and causes the clamp to move along the ring or arcuate member until a fresh clamping position is reached. In this new clamping position, the clamp is again clamped to the ring or arcuate member and the procedure is repeated.

Preferably, while the actuation clamp is released from the ring or arcuate member, and is being moved to its new clamping position, a second or auxiliary clamp, connected to the body (via an associated rigid arm, if necessary) is clamped to the ring or arcuate member to hold the body steady and negate any adverse effect of wind on the body.

Hence, according to the present invention, there is provided a mechanism for the controlled rotation of a body about an axis, said mechanism comprising:

- a) a ring member or arcuate member, the centre of curvature of which is positioned at the axis of rotation of said body;
- b) an actuation clamp mounted on said ring member or arcuate member for movement therealong, said actuation clamp being releasably clampable onto said ring member or arcuate member;
- c) a linear expansion and contraction device having two end connections that are

moveable substantially linearly towards and away from each other; one of said end connections being connected to said actuation clamp; the other of said end connections being connected to said body or to a rigid arm connected rigidly to said body;

5 whereby, when said actuation clamp is clamped onto said ring member or arcuate member and said linear expansion and contraction device is activated to move said end connections towards or away from each other, said body (or said rigid arm and hence said body) is rotated about said axis of rotation.

As noted above, preferably

- 10 1) said expansion and contraction device is positioned with the line between its end connections being above, and substantially tangential to, said ring member or arcuate member; and
- 2) an auxiliary clamp is also mounted on said ring member or arcuate member for movement therealong, said auxiliary clamp being releasably clampable onto said
- 15 ring member or arcuate member; said auxiliary clamp being connected to said body or to a respective rigid arm that is rigidly connected to said body; said auxiliary clamp being clampable onto said ring member or arcuate member when said actuation clamp is not clamped onto said ring member or arcuate member.

20 In a further preferred form of the present invention, the auxiliary clamp is connected to said body (or to a rigid arm rigidly connected to said body) via a second linear expansion and contraction device.

The present invention also encompasses a clamp which may be used in the forms of the present invention recited above.

25 These and other features of the present invention (some optional) will be featured in the following description of embodiments of the present invention, which is provided by way of example only. In the following description, reference will be made to the accompanying

drawings.

Brief description of the accompanying drawings.

Figure 1 is a partly schematic sketch of a dish antenna, equipped to be rotated about a vertical axis by the present invention.

- 5 Figure 2 is a partly schematic plan view of another dish antenna, equipped to be rotated about a vertical axis by the present invention.

Figure 3 is a schematic plan view of a modified form of the present invention.

Figure 4 is a schematic top view of a dish antenna mounted for linear movement along a wall or rail.

- 10 Figure 5 shows one form of clamp that may be used in the rotation arrangements depicted in Figures 1, 2 or 3, and in the linear movement arrangement shown in Figure 4.

Figure 6 illustrates a different clamp construction that may be used in the rotation arrangements depicted in Figures 1, 2 or 3, and in the linear movement arrangement shown in Figure 4.

15 **Detailed description of the illustrated embodiments.**

- Figures 1 and 2 each show, schematically, a dish antenna to be rotated about a vertical axis 12. The dish antenna for which the present invention was developed is a large solar collector which has been assembled at The Australian National University, in Canberra, Australia. That solar collector has been described in the specifications of, inter alia, 20 Australian patents Nos. 677,257 and 700,607 and US patents Nos. 5,757,335 and 5,934,271. However, it is emphasised that the solar collector and the dish antennae featured in Figures 1 and 2 are only examples of a rotatable structure with which the present invention may be used and the present invention is not limited in its application to

solar energy collectors generally, or to antenna configurations which are similar to those illustrated in Figures 1 and 2.

5 The antennae illustrated in Figures 1 and 2 each have a dish 10 supported on a base frame 11. The support of the dish on the base frame is shown schematically in Figure 1 by columns 13 and unit 14. Unit 14 includes a known form of mechanism for pivotally moving the dish 10 about a horizontal tilt axis (not shown in the drawings), to change the elevation of the line of sight (or pointing axis) 21. Typically, the elevation of the pointing axis 21 of the dish is effected using a hydraulic ram arrangement which controls the movement of a sub-frame. However, any other suitable drive mechanism (such as a screw
10 drive or a rack and pinion mechanism, or a modified form of the present invention) may be used for this purpose.

15 The base frame 11 (as indicated above) is mounted for rotation about a vertical axis 12. The axis 12 is at the centre of a circular track, or ring member 16. In conventional large dish antennae, the ring member 16 is a circular toothed track and rotation of the base frame about the vertical axis is effected by motors which drive pinions that engage with the "teeth" of the toothed track. In the present invention, a toothed circular track is not required. The ring member 16 may be any convenient structure onto which a clamp may be rigidly attached. Preferably, the ring member 16 is a circular I-beam, or a wall structure, or a circular foundation for a dish antenna, onto which clamps of the type
20 illustrated in Figure 5 or Figure 6 may be mounted.

The base frame 11 of the dish antenna of Figure 1 has a rigid arm 15 rigidly attached to it. The end 15A of the arm 15 is constructed to (or has a device attached to it so that it can) be moved freely along the ring member 16.

25 An "actuator clamp" 18 is mounted on the ring member 16. The actuator clamp 18 grips the circular ring member 16 by virtue of a force (which may conveniently be provided, for example, by a compressed spring) which is maintained continuously, unless released by

deliberate action of a clamp release device, which may be hydraulically (or otherwise) operated. Such release of the clamp is made only whenever it is required to move the location of the clamp to a new position along the ring member 16.

5 The actuator clamp 18 is connected to the end of the arm 15 which is remote from the base frame 11 by a linear expansion and contraction device, namely (in the arrangement shown in Figure 1) a double-acting hydraulic ram 17. Another device which performs the same expansion and contraction function as the double-acting ram 17 may be used in its place. As shown in Figure 1 (and also in Figures 2 and 3), the double-acting ram 17 is essentially above, and aligned substantially tangentially to, the ring member 16.

10 An auxiliary clamp 20 is also mounted on the ring member 16. The auxiliary clamp 20 is rigidly connected to a second rigid arm 19 which, in turn, is rigidly connected to the base frame 11. The auxiliary clamp 20 also grips the ring member firmly unless it is deliberately released.

15 To rotate the base frame 11 about the axis 12, the actuator clamp 18 is maintained in its clamping mode, auxiliary clamp 20 is released and the double-acting ram 17 is expanded or contracted. If the ram 17 is expanded, the arm 15 is forced away from the actuator clamp 18 so that the base frame 11 is rotated about the axis 12 (and the arm 19, with its associated clamp 20 is also moved) in a clockwise direction. If the ram 17 is contracted, the arm 15 is moved towards the clamp 18 and the base frame is rotated about the axis 12
20 (and the arm 19, with its associated clamp 20, is also moved) in an anti-clockwise direction.

When the required (or maximum possible) expansion or contraction of the ram 17 has occurred, the clamp 20 is activated and the clamp 18 is released. Activation of the ram 17 now causes the clamp 18 to move along the ring member 16 until it reaches a new required position. The clamp 18 is then activated as the clamp 20 is released, and the ram 17 is
25 again operated to move the arm 15, and also the arm 19 and the released clamp 20, over the ring member 16, and to rotate the base frame 11 about the axis 12.

It should be apparent that the clamp 20, via its associated rigid arm 19, holds the base frame 11 rigidly relative to the ring member 16 while the actuator clamp 18 is moved along the ring member, thus preventing rotation of the dish 10 should any strong wind blow on the antenna during this time of movement of the clamp 18 to its new position on the member 16.. In fact, if, as will normally be the case, the ring member 16 is attached to, or comprises, the foundation of the dish antenna installation, the auxiliary clamp 20 causes the member 16 (and anything to which it is attached - for example, the foundation for the antenna) to be a "counterweight", which further contributes to the stability of the dish antenna in gusty and strong winds.

At least one further auxiliary clamp (clamp 22 shown schematically in dashed outline in Figure 1) may be mounted on the ring member 16 and be connected to the base frame 11 by a further rigid arm 23. The clamp 22, and any more auxiliary clamps similarly mounted on the antenna, will be activated in the same manner, and at the same time, as the clamp 20, to provide yet further aid to the stability of the antenna while the clamp 18 is moved from one clamped position to another, particularly when the dish is tracking near the horizon. And in very strong winds, when the dish is not operational but has been moved to its "survival mode" position, pointing vertically upwards, this clamp provides further protection against the toppling of the antenna

Activation of the clamps 18 and 20 (and any further auxiliary clamp or clamps, if present), and also activation of the double-acting ram 17 (or an equivalent device) will normally be controlled by control signals provided by a shaft encoder (not shown in the drawings) which is mounted on the axis 12.

Referring now to Figure 2 (in which - as in Figure 3 also - components which are essentially the same as those which have been featured in Figure 1 have been given the same reference numbers as in Figure 1), it should be noted that the only major difference between the tracking or scanning antennae of Figures 1 and 2 is that the arms 15 and 19 (and 23) are absent from the Figure 2 embodiment. That is because the relative sizes of the

base frame of the dish antenna and the ring member 16 of the Figure 2 embodiment are such that parts of the base frame overlap the ring member. In this situation, the actuator clamp 18 and the auxiliary clamp 20 (and clamp 22, if present) are mounted directly on the base frame, and one end of the linear expansion and contraction device (the double-acting ram 17) is connected to the base frame at 15A. The rotation of the base frame 11, and hence of the dish 10, about the axis 12 is achieved using the clamps 18 and 20 (and 22) and the expansion and contraction device 17 in the same way as these components have been used in the embodiment of Figure 1. Further description of the operation of the embodiment illustrated by Figure 2, therefore, is unnecessary.

The period during which the clamp 18 is released and is moved along the ring member 16 can be made very short relative to the time periods in which it is necessary to adjust the position of the base frame to cause the pointing axis of the dish to follow the motion of the sun (in the case of a solar collector) or a star. For such very short time periods, a short "throw" of the linear expansion and contraction device 17 should be used. It should also be noted that the position of the body (the base frame 11) being rotated, relative to the axis of rotation, can be indicated by the reading of a shaft angle transducer (or encoder), and it is this reading which is used by the computer control system to control and effect the rotation of the body. Thus it is not necessary for the actuator clamp 18 to be moved exactly the same distance along the ring member 16 each time the position of this clamp is changed. Also, neither the actuator clamping mechanism nor the linear expansion and contraction device need to be precise or adjustable in their operation. The actuator clamp is not required to be located at any specific position (given the extension and contraction capabilities of the ram 17 or other linear activator), except to allow the actuator ram 17 to be able to move the body 11 in rotation about its axis 12. The only component in a tracking dish antenna system that has to be accurate is the shaft encoder (or similar measurement device) for measurement of the body's actual angular orientation on its axis, and (in the case of a solar collector dish antenna) the appropriate sun model which provides the sun's position at all times of the day.

It has been noted already that the rotation of the dish antenna of Figure 1 can occur in either direction, in accordance with the computer control of the position of the dish. For solar energy collection, it is not necessary for the rotation of the dish antenna about its vertical axis to occur over one complete revolution. The sun can be adequately tracked provided the rotation can occur over $\pm 150^\circ$, centred on true geographical north. However, for other reasons (such as orienting the dish to point away from the sun), rotation over $\pm 180^\circ$, centred on true geographical north, will be more convenient.

It is not necessary for the clamps 18 and 20 to be widely separated on the ring member 16. In fact, the separation of the clamps 18 and 20 shown in Figure 3 is approximately that to be used in the aforementioned solar collector constructed in Canberra, Australia.

In some applications of the present invention (for example, when the body to be rotated is an optical telescope or radio telescope), the rotation has to be truly continuous. That is, despite the possibility of rapid change of the position of the actuator clamp 18 on the ring member, the short period in which the body is not rotating is unacceptable. In this situation, an arrangement as illustrated in Figure 3 may be used to rotate the body.

The body 11 of the Figure 3 embodiment is rotatable about a vertical axis 12 (which is also the centre of curvature of the ring member 16), as described above, by the operation of the actuator clamp 18 and the double-acting ram 17. However, a further rigid arm 25 is rigidly connected to the body 11. One end of a second double-acting ram 27 (or similar linear expansion and contraction device) is connected to the end of the arm 25 where it overlies the ring member 16. The other end of the ram 27 is connected to a second actuator clamp 28, mounted on the ring member 16 in the same manner as the actuator clamp 18.

The rotation of the body 11 is effected using a clamp 18 and ram 17 as described above. However, shortly before that motion ceases, the second actuator clamp 28, which has been moved to a predetermined position on the ring member 16, is clamped onto the ring member 16 and, simultaneously, the ram 27 is activated to assist in the conclusion of the

rotation initiated by the ram 17 and to take over the task of rotating the body 11 while the clamp 18 is released from the ring member and moved to its new position. When the ram 27 is nearing the end of its throw with the clamp 28 clamped to the ring member 16, the clamp 18, which is now in its new position, is clamped to the ring member 16 and ram 17 is activated to assist in the final stage of the rotation of the body by the action of the ram 27 and to take over the rotation of the body while the clamp 28 is released from the ring member and moved to its next position.

This alternate, but slightly overlapping, use of the combination of (a) clamp 18 and ram 17, and (b) clamp 28 and ram 27, continues under the control of the microprocessor that monitors the shaft encoder, which shows the orientation of the body 11 relative to its axis of rotation 12.

It will be appreciated that, in a similar way, three (or more) actuator clamps, each with its own associated expansion and contraction device, could be used to effect truly continuous rotation of the body 11. With such an arrangement, continuous rotation of the body can be maintained if one of the hydraulic rams (or other linear expansion and contraction devices) should fail.

It should also be appreciated that if the arrangement shown in Figure 3 (or an arrangement with three or more actuator clamps) is adopted, the auxiliary clamp 20 has become a redundant clamp during the rotation of the base frame. However, an auxiliary clamp 20 may be retained in the arrangement for additional secure clamping of a dish antenna when the rotation of the body 11 is stopped. Such a situation will occur, for example, if a solar energy collector with a large dish is stopped either (a) because it is being buffeted by strong winds, or (b) in the period of dusk to dawn, when the sun is not over the horizon.

In each of the arrangements featured in Figures 1, 2 and 3, the ring member may be replaced with an arcuate member if complete rotation of the body is never required. Such an arcuate member would have its centre of curvature at the axis of rotation 12.

Figure 4 illustrates the use of the present invention in a situation where the ring member is replaced with an arcuate member of finite length but with an infinite radius of curvature (that is, a linear member 46). In the arrangement shown in Figure 4, a body 41 - which may be the base frame of a dish antenna which is part of an array of dish antennae set up as an interferometer - is to be moved in the direction *A* or *B*, parallel to the linear member 46. A rigid arm 45 extends from the base frame 41 to overlie the linear member 46. One end of a double-acting ram 47 is connected to the end of the arm 45 which is remote from the base frame 41. The other end of the double-acting ram 47 is connected to an actuator clamp 48 which is mounted on the linear member 46. A second rigid arm 49 extends from the base frame 41 to overlie the linear member 46. An auxiliary clamp 50 is mounted on the linear member 46 and is rigidly connected to the arm 49.

To move the body 41 in the direction *A* or *B*, the actuator clamp 48 is clamped to the linear member. The clamp 50 is released and is free to move along the member 46. The double-acting ram 47 is activated and, since the end attached to the clamp 48 cannot move, the rigid arm 45 (with its support frame 41 and the dish 40) is moved by the expansion or contraction of the ram 47. As the support frame 41 moves, so does the arm 49 and the clamp 50. When the ram 47 has reached the end of its intended throw, the auxiliary clamp 50 is clamped to the linear member 46 and the clamp 48 is released. The clamp 48 is then moved along the member 46 to a new position and, once repositioned, the clamp 48 is reactivated, so that it is again clamped onto the member 46. This sequence is then repeated.

Normally, the base frame 41 will be mounted for movement along a rail which is (or, preferably, a pair of parallel rails 51 which are also) parallel to the elongate direction of the linear member 46. If the dish antenna is large and heavy, the linear member 46, and the arms 45 and 49 with their associated linear expansion and contraction device 47 and the clamps 48 and 50, may be duplicated on the other side of the rail or rails 51. With this arrangement, the base frame 41 will be moved by the pair of rams (or similar devices) 47 and their associated clamps, acting in synchronism with each other.

The clamps shown schematically in Figures 1 to 4 may be any one of a number of different clamp constructions, depending on the nature of the ring (or arcuate) member 16 or the linear member 46. Normally, all the clamps used in the body rotation arrangement will have the same construction. The important feature of each clamp is that (a) the clamp
5 applies a clamping force to the member 16 or 46 until the clamping force is deliberately removed, and (b) in the event of a failure of the power applied to the system controlling the movement of the body, the clamping force applied by the clamp to the member 16 or 46 is maintained (if the force has been applied at the time of the power failure) or is immediately applied. Thus, if the power supply fails, the body being moved will remain
10 in its position at the time of the power failure, clamped to the member 16 or 46 (that is, in the case of a large dish antenna, in its most protected and stable position).

One clamp construction, which has been devised by the present inventor for use as a clamp in the arrangements depicted in Figures 1 to 4 and described above, is illustrated in Figure 5. In this construction, for use when the member 16 or 46 is an I-beam, the clamp has a
15 yoke member 52. The yoke member 52 has a pair of arms 52A and a top cross-member 52B. Each arm 52A carries, on its upper surface, a friction pad 58. A further, central friction pad 59 is mounted on a plate 61 that is attached to the lower end of a shaft 60 that passes through the cross-member 52B. A second plate 54 is mounted on the shaft 60, below the cross-member 52B. The second plate 54 can move freely on the shaft 60 and the
20 shaft 60 can move freely through an aperture in the cross-member 52B. A strong helical spring 57 is positioned substantially coaxially on the shaft 60, between the plates 54 and 61. Four bolts 55 (which, preferably, are substantially equispaced from each other and are positioned symmetrically relative to a plane at right angles to the drawing which passes through the centre of the shaft 60) pass through threaded apertures in the cross-member 52B
25 and are screwed down until the friction pad 58 and the friction pads 59 exert a predetermined force against the top member of the I-beam 16 or 46. This predetermined force is sufficient to clamp the yoke 52 to the I-beam, without movement of the clamp assembly when the ram 17 or 47 is activated to move (rotate) the body 11 or 41.

At the end of the throw of the ram 17 or 47, when the movement of the body ceases, the force exerted on the I-beam by the friction pads 58 and 59 is removed by activating the clamp removal device 53, to cause the shaft 60 to be lifted against the action of the helical spring 57. The clamp removal device 53 may be a hydraulic ram, a solenoid, a cam, or any other suitable device which can be operated to lift the shaft 60.

With the clamp removal device 53 activated, the yoke 52 (and with it, the components mounted on it) can be freely moved along the I-beam or rail 16 or 46 under the action of the ram 17 or 47. Movement along the I-beam or rail is facilitated by wheels 56 which are mounted on the yoke 52. When the yoke 52 has reached its new position, the clamp removal device 53 is deactivated, the pads 58 and 59 (by virtue of the increased compression of the spring 57) are moved to contact and again exert a force against the I-beam or rail, and the clamp is once again clamped onto the I-beam to permit movement of the body 11 or 41 as the ram 17 or 47 is expanded or contracted.

Figure 6 depicts a clamp which acts in a similar manner to that shown in Figure 5, but is constructed to clamp against a "wall" or similar foundation member 16 (if ring-shaped or arcuate) or 46. This clamp has a yoke 62, which is a different shape from the yoke of the Figure 5 clamp, with two arms 62A and 62B. The arm 62A carries a friction pad 68 which is positioned adjacent to one side face of the "wall" 16 or 46. A second friction pad 69 is mounted on a plate 71 at the end of a shaft 70. The shaft 70 can move freely within an aperture in a plate 64 (against which the ends of four bolts 55 - similar to the four bolts 55 in the Figure 5 embodiment - bear). A strong helical spring 57 is positioned substantially coaxially on the shaft 70, between the plates 64 and 71. The arm 62B carries a support plate 72 on which are mounted the clamp removal device 53 and (in threaded apertures) the bolts 55 which are used to adjust, by compression of the strong helical spring 57, the force applied by the friction pads 68 and 69 to the wall 16 or 46. Wheels 66 are provided to facilitate the movement of the yoke 62 (and its attachments) along the wall 16 or 46.

Other forms of clamps may be used with the rotation or linear movement arrangements of

the present invention, provided they have the essential operational features noted above (in particular, that, in the event of a power failure, the clamping force is maintained (or is re-established), thereby ensuring that the body is held firmly against the member 16 or 46.

5 The drive mechanisms and clamps illustrated in the accompanying drawings and described above are simpler, less expensive and more likely to be trouble free than the conventional drive mechanisms and clamps used in the rotation of large dish antennae. They can also be used, with advantage, to rotate, or move linearly, other bodies.

10 It should be appreciated that the embodiments of the present invention which are illustrated in the accompanying drawings and described above are examples only of realisations of the present invention, which may be varied or modified without departing from the present inventive concept.

Dated this 28th day of October 2003.

Anutech Pty Limited,

By its Patent Attorneys

15 **Davies Collison Cave.**

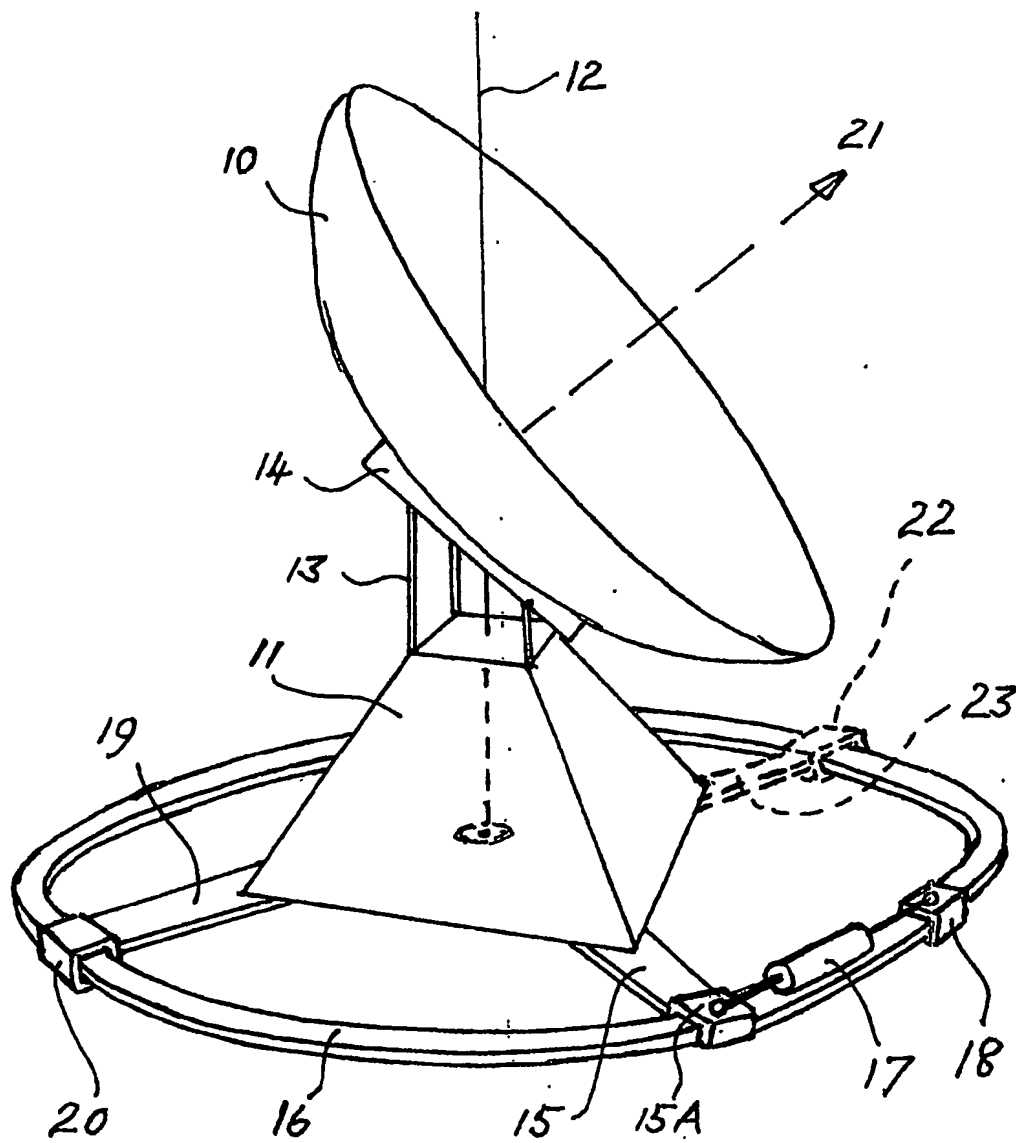
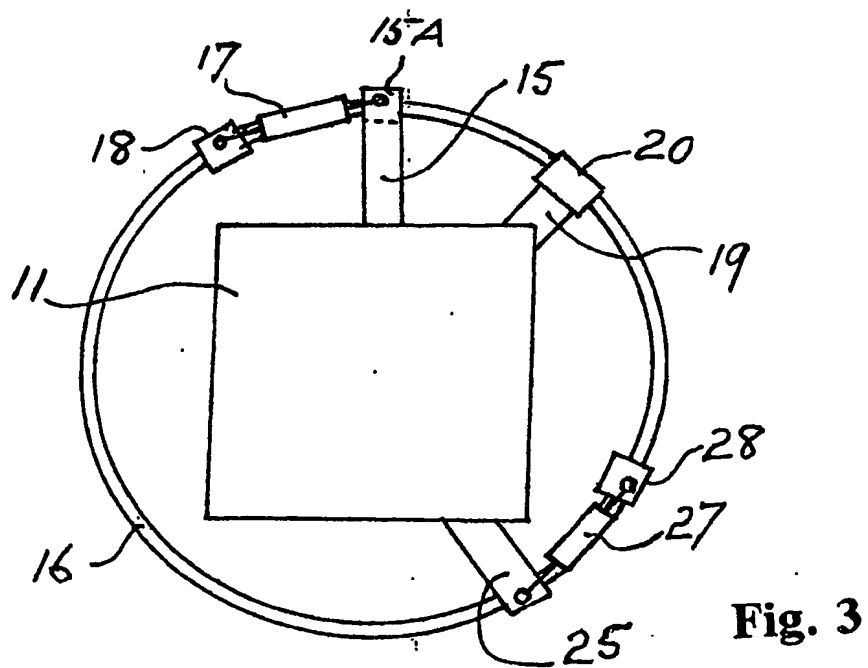
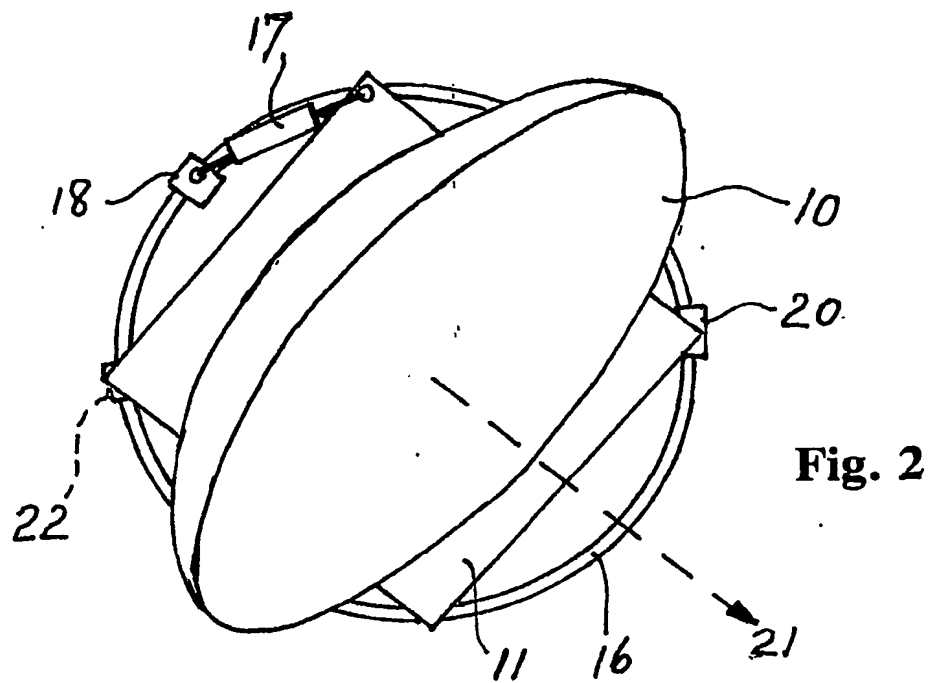


Fig. 1



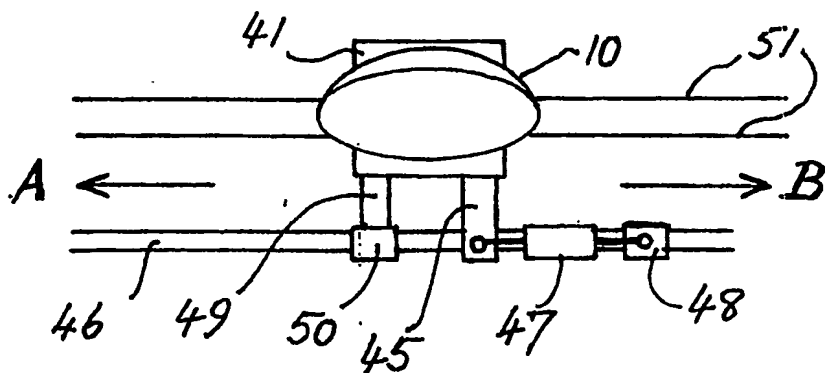


Fig. 4

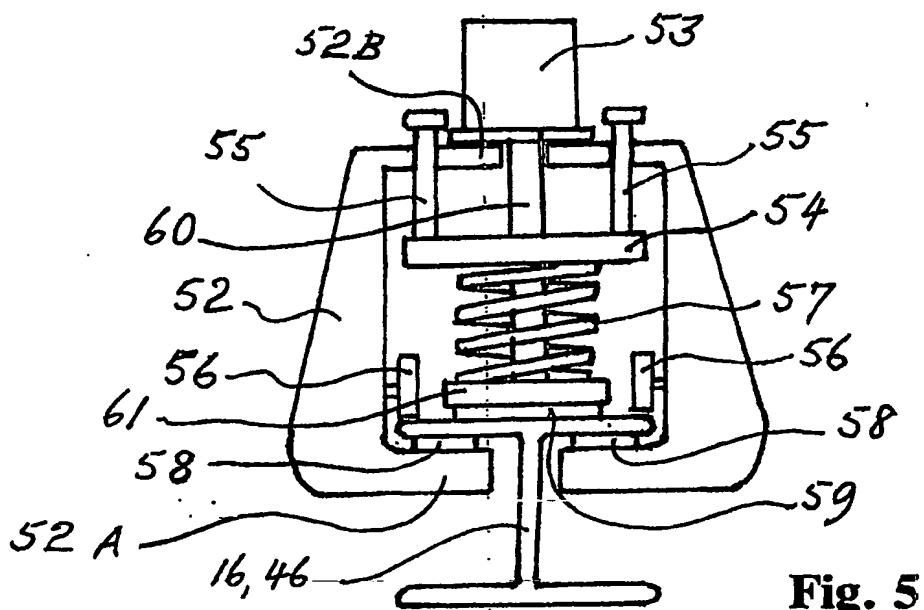


Fig. 5

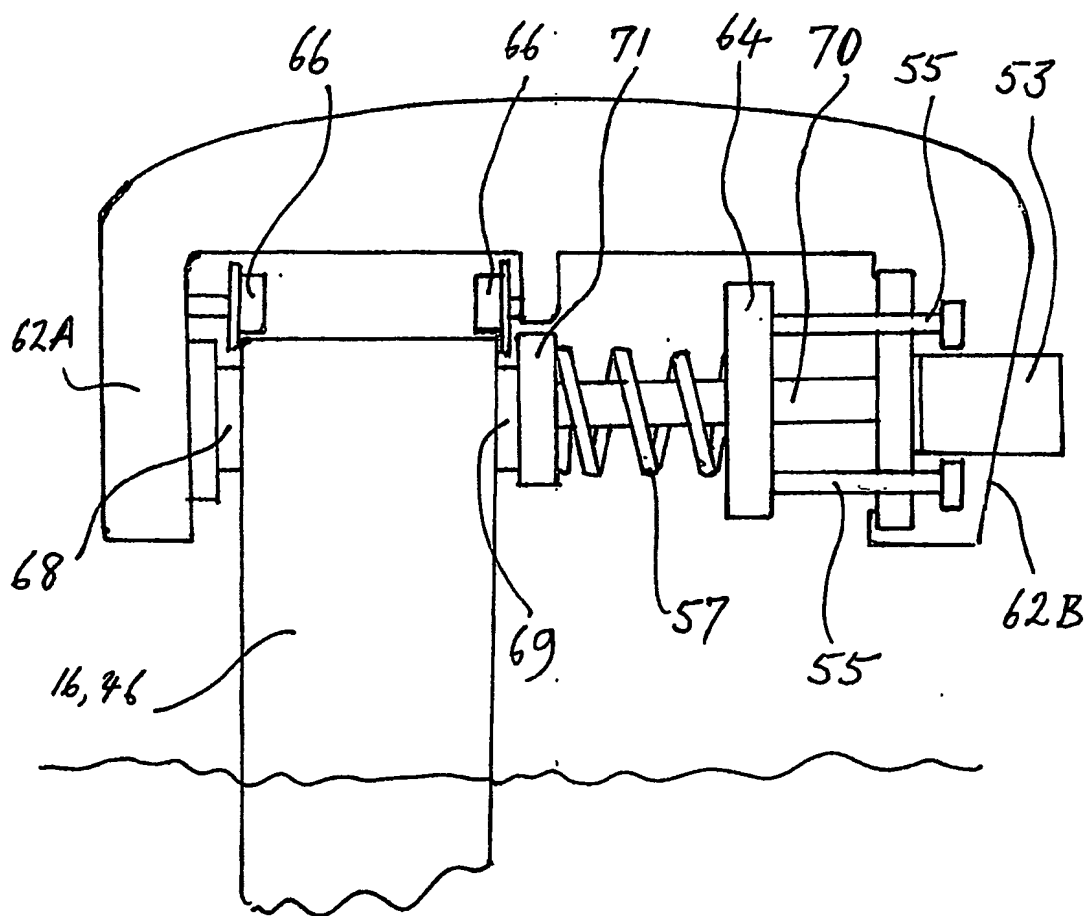


Fig. 6

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